



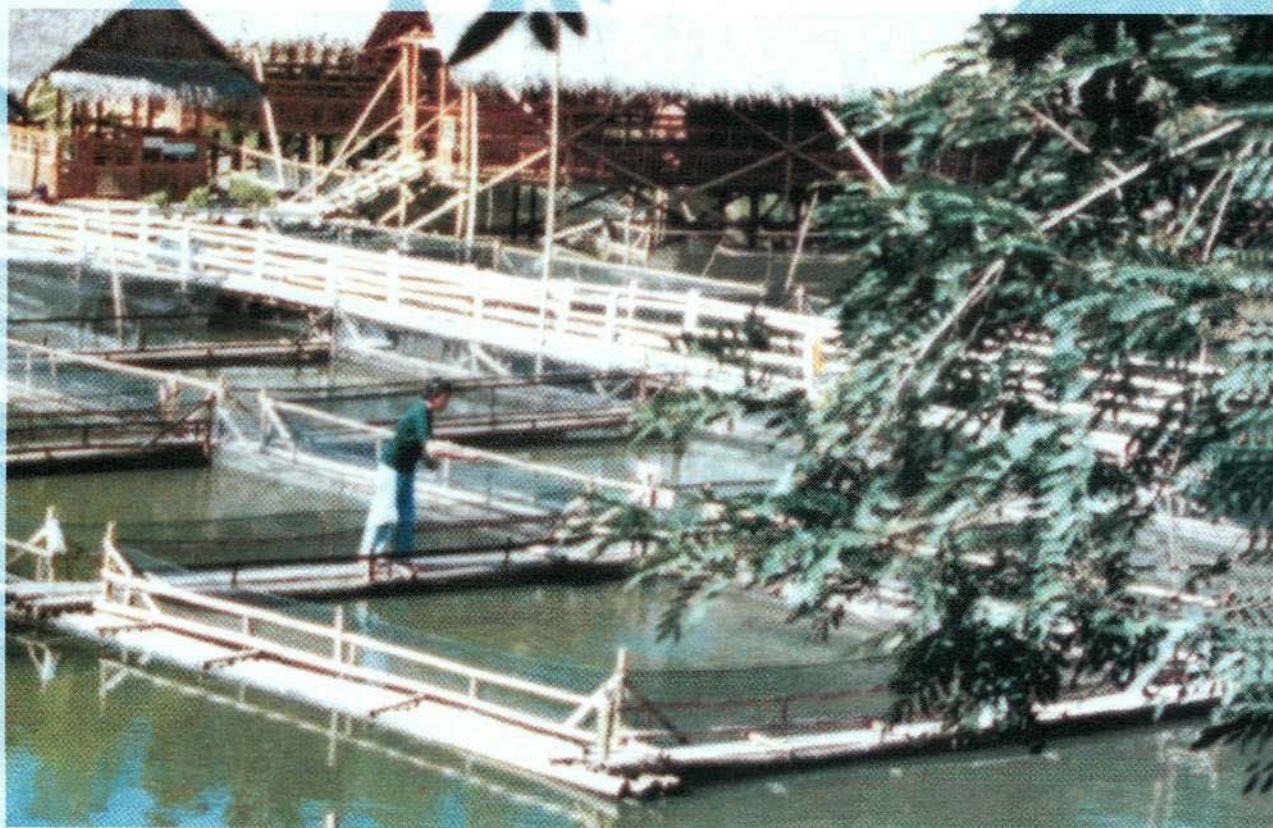
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1997 Highlights



Aquaculture Department

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
Tigbauan, Iloilo, Philippines

AQD in 1997

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1997 was a good year for AQD. Its research output, currently measured in terms of the number of scientific papers published, has increased. For 1997, a total of 40 papers were published in scientific journals, edited proceedings, and other publications. In all, AQD continued to contribute quality research information, the first step in technology generation.

For technology verification and demonstration, AQD packaged and field-tested various technologies (10 projects in all). These were conducted in private fishfarms in west central Philippines.

Through the years, the themes of AQD's research and development efforts are poverty alleviation, food security environment-friendly techniques, and export or cash crops. A few notable examples in 1997:

- The community fishery resource management (CFRM) project in Malalison Island and Honda Bay
- The technical assistance to local government units on low-input aquaculture products like tilapia and mussel-oyster
- The development of mudcrab culture techniques in reforested mangrove areas, and the rehabilitation of mangroves / abandoned ponds through aquasilviculture
- The continued research on high-value species like tiger shrimp and 22 other species of economic importance in southeast Asia. About 27 research projects were implemented in 1997. Another 24 studies are collaborations with various organizations and agencies.

In terms of technology transfer, AQD continued to train aquaculture manpower (94 attended six short-term training courses and more than 220 availed of individual and special training programs). AQD for the first time conducted training outside the Philippines, the *Sustainable Aquaculture and Coastal Resource Management* at Cantho University in Vietnam. AQD was also involved in the revision of the curriculum leading to the Diploma in Fishery Technology of fishery schools in east central Philippines.

AQD consolidated its information activities, publishing only one bimonthly newsletter beginning June 1997, placing a website in the Internet, and utilizing the mass media (mainly print) to publicize program and research results.

Regarding industry feedback and participation to AQD's R&D activities, 1997 has clearly defined three areas of industry involvement.

The first area is industry participation in the R&D planning workshops which are designed to fine-tune AQD's research programs.

The second is the involvement of fishfarmers in field-testing AQD technologies. For AQD, private fishfarms have become demonstration sites to ensure commercialization of its technologies. For the farmer, there is assurance of technical support and a way of relating directly to AQD researchers. For AQD researchers, this will ensure immersion in the industry.

The third area is training and information support. Training courses can be tailored to the needs of requesting parties, while requests for information are attended to speedily. The AQD Library which holds the latest information in tropical aquaculture increased its holdings by more than 500 volumes.

Indeed, 1997 can be seen as the definitive year of industry linkage. Incidentally, it marks the second year of the change in AQD thrusts. Back in mid-1996 when Dr. Rolando Platon assumed the AQD Chief post, he promised to "have a strong hand in technology verification and aquaculture extension, and bridge the gap between AQD's considerable research output and the industry's need for sustainable technologies ... AQD must verify and then demonstrate and extend the technologies it can generate."

Community fishery resources management

AQD is collaborating with the International Center for Living Aquatic Resources Management (ICLARM), the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), and the Tambuyog Development Center, a local non-government organization, for a project to promote the protection of coastal resources and welfare of local communities.

The project site is Honda Bay in Puerto Princesa City Palawan. The project focuses on community-based management to achieve eq-



uitable, efficient, and sustainable use of coastal resources. The project is based on AQD's experience in its community fishery resource management project in Malalison Island, Antique.

One of AQD's tasks is to spearhead the dissemination and transfer of technology to Palawan-based institutional partners and fisherfolk organizations of Barangay Manalo and Tagburos. An initial activity is aquasilviculture.

If the pilot project is successful in the Philippines, similar co-management schemes will be done in other SEAFDEC member countries starting 1998.

Community Fisheries Resources Management project leader R. Agbayani and scientist LMB Garcia discuss marine reserve concepts with cooperators at Malalison Island, Antique.

Tilapia culture in small water impoundment

Technology verification project technician U. Derotas works on the net cage culture of tilapia in a small freshwater reservoir in Bingawan, Iloilo. AQD collaborates with the LGU and the Bingawan Multi-purpose Cooperative.



The Technology Verification Project which was launched in mid-1996 aims to intensify technology verification activities by field testing specific culture systems in selected farm sites, and to package technologies that are found to enhance productivity and/or profitability. These verification studies consider site specific conditions, such as, socio-economic, environmental, biological, anthropological, and other related aspects. An important feature is the active participation of the fisherfolk and the local government units.

One such technology verification project is AQD's collaboration with the local government unit of Bingawan, Iloilo and the Bingawan Multi-Purpose Cooperative for the netcage culture of tilapia in a small freshwater reservoir.

The target beneficiaries of the project are the people of Bingawan who will have options to improve their living condition.

Nile and red tilapia

Selective breeding studies were conducted on the Nile tilapia strain from Thailand and a Philippine red tilapia strain. The conventional mass selection procedure for stock improvement was modified by early size-grading and culling of large fry before the final selection was applied. Response to size-specific mass selection for growth rate after one generation of selection is positive. The selected offspring of the Nile tilapia are 2 to 3% larger than the control



Selective breeding and broodstock management of red tilapia are researches being conducted in two fishfarms in Calauan, Laguna, and Tanay, Rizal.

unselected fish. This modified mass selection procedure is now being pilot-tested in two private commercial tilapia hatchery farms. The objective is to help farmers develop their own tilapia broodstock.

On the other hand, the red progenies of a red tilapia hybridized (introgressed) with Nile tilapia grew significantly faster than the progenies of the unhybridized red tilapia. A directional size-specific mass selection has been applied on the F4 introgressed red tilapia. This is to select for a fast-growing red tilapia strain.

In another study, the growth and survival of five red tilapia strains were compared in brackishwater and seawater. The NIFI strain obtained from Thailand showed the highest mean specific growth rate in brackishwater. On the other hand, a Philippine strain obtained from a private fish farm showed the highest mean specific growth rate in seawater.

Oyster and mussel

Verification and commercialization of the hanging raft technology for oyster and mussel in Batan, Aklan and Ivisan and President Roxas in Capiz started in September 1997.

The oyster facility in Ivisan showed spatfall attachments on October 2 - 9, and again on November 30 - December 6; the one in Batan showed attachments on November 7 - 13; the facility in President Roxas had spatfall on October 22 - November 5.

Calculations for spatfall in mussels indi-

cate that in Batan, it may have occurred between November 14 and 20; November 6 - 13 in President Roxas; and about December 5 - 12 in Ivisan.

Density adhesions for oysters in the different sites are as follows: President Roxas, 652 per block; and 56.1 per shell in the "broadcast"; 19.2 spats per shell in Ivisan, and 13.9 spats per shell in Batan.



Feeding rotifers enriched with vitamin C and highly unsaturated fatty acids to hatchery-reared milkfish larvae reduces incidence of abnormalities. (Note cleft branchiostegal membrane; normal larvae on the right)

Milkfish

AQD collaborated with five former shrimp hatchery operators who underwent intensive training on milkfish hatchery operations prior to undertaking commercial milkfish fry production. Fry survival in these private hatcheries were initially low but reached an average of 36.6% during the latter part of the season. Low fry survival rates were mainly due to delayed harvest (fry were harvested after day 35). The hatchery operators met with difficulties in selling their fry to milkfish farmers who were hesitant to use hatchery produced fry.

Participants of the one-day conference on the culture of hatchery-bred fry held last July 9 (see page 11) also identified poor market acceptability of hatchery fry because of perceived slow growth and high incidence of abnormalities as a major problem in accelerating the transfer of milkfish hatchery technology. By feeding milkfish larvae with rotifers enriched with vitamin C and highly unsaturated fatty acids (HUFA), the incidence of abnormalities was reduced and fry survival rate was significantly increased in commercial scale hatchery runs. High survival rates of up to 80% were also obtained when larvae were reared at low stocking densities of 6-7 larvae/1 (semi-intensive rearing) and fed copep-

The hanging raft technology of mussels is being verified for commercialization in Aklan and Capiz.



Mudcrab culture in mangroves



AQD is developing a model farm where mudcrab are raised in mangrove reforested areas.

The trial on mudcrab culture in tidal flats with existing mangroves at New Buswang (Kalibo, Aklan) is nearly complete.

The 0.24 ha experimental farm is divided into 12 compartments of 200 sq m each, surrounded by a netted enclosure 50 cm higher than the level of the highest tide. Twenty to 30% of each compartment area is laid out for canals 50 cm wide and 50 cm deep. A dike 50 cm high surrounds the pens for retention of water at a depth of 80-100 cm at lowest tide.

A study tests the effects of two types of feed (salted trash fish only and a mixed diet of 75% salted mussel meat and 25% trash fish) and different stocking densities (0.5 and 1.5/sq m) on growth, FCR, survival and production of mudcrab. Based on stock sampling 120 days after stocking, mean body weight of crabs was 253.0 g and 239.6 g for stocking density of

0.5 and 1.5/sq m and 239.0 g and 253.6g for trash fish and mixed diet, respectively. Harvest of crab is due on February 1998.

A similar project is being done in Brgy. Manalo, Puerto Princesa, Palawan.

AQD is also pursuing the rehabilitation of mangroves /abandoned ponds through aquasilviculture. A site has been chosen in Banate, Iloilo. Two treatments (ponds) are in the process of renovation / construction: (1) shrimp intensive monoculture pond of 1,500 m² and (2) mangrove pond of 1,300 m² for filtration of shrimp pond effluents. A third treatment (pond) - that of the integrated culture of shrimp / fish and mangroves without the addition of any effluents - will be added in 1998.

Laguna de Bay an ecosystem approach to sustainable management

A four-year collaborative project with the European Union and two Philippine institutions including AQD was implemented in 1995.

The objective is to develop a scientific base for the sustained and rational utilization of Laguna de Bay in the Philippines especially for fisheries and aquaculture.

Preliminary results show different conditions of the lake from year to year. Factors influencing saltwater intrusion in the lake as well as the movement of salt water have been studied. Sampling to determine feeding periodicity of wild and cultured fishes has been completed; the collected fishes are being processed for further chemical analysis. Experiments on algae are ongoing.



ods and rotifer.

Improved broodstock feed formulation is also a continuing effort at SEAFDEC AQD. Increased egg production, more frequent spawnings, higher hatching rate and percent normal larvae were obtained when the regular broodstock feed was supplemented with small quantities of vitamin C and phospholipid.

Pond snails compete with milkfish for food

and disrupt lablab growth. Granular commercial grade (10% active ingredient) metaldehyde, a biodegradable molluscicide, can control dense populations of snails (2,000 snails/m²) in commercial ponds under wet or dry conditions at an effective dose of 120 kg/ha. The granules dissolve within three days and 84-99% of the metaldehyde disappear in pond soil and water within 15 days of application.



Labeling of experimental animals for proper identification and monitoring is part of the study conducted on mudcrab in collaboration with the Australian Center for International Agricultural Research.

Mudcrab

AQD has successfully spawned the mudcrab, raised larvae to megalopa in the hatchery, and reared megalopa to crablets in hapa nets in nursery ponds. Now, studies are focused on refining broodstock management, hatchery and nursery techniques.

One study evaluated reproductive performance of mudcrab fed different diets. The combination diet (natural food + artificial diet) was best.

The survival and development of mudcrab larvae fed artificial diets and natural food were also compared. Supplementation of artificial diet markedly improved larval survival.

Another study focused on the changes in the foregut of zoea 1 to megalopa. The morphological changes have implications on the feeding abilities and stage-specific feeding regimes appropriate during culture.

For grow-out, the growth, survival, and production of monosex mudcrab in ponds were compared. Three stocking densities were tested - 0.5, 1.5 and 3 ind/sq m. The highest net income was from 1.5 ind/sq m. Partial budgeting analysis revealed that net benefit (P73,635.00; US\$1=P25) increased as stocking density was increased from 0.5 to 1.5 ind/sq m but not when increased to 3 ind/sq m. Comparative cost return analysis showed that higher profit, ROI, and lowest production cost were attained with the male monoculture.

AQD made a series of technology verification runs on mudcrab culture in brackishwater ponds enclosed with nylon nets. These were conducted in Jalandoni and Montelibano Farms in E.B. Magalona and Gargarita Farm in Himamaylan, all in Negros Occidental. Results are encouraging. Each 0.5

ha pond produced 724 kg mudcrab after a series of selective harvests (stocking density, 1 ind/sq m). Length of culture is about 130 days. Survival ranged 63-72%, average crab weight at harvest ranged 285-389 g. Average feed (trash fish) consumed was 3,797 kg, or a feed conversion ratio of 5.2. Based on the initial weight at stocking, the mean relative growth increment was 2.35 g/day/crab.

AQD intends to carry out more verification runs in other parts of the country.

Giant tiger shrimp

On shrimp broodstock development, feeding experiments were carried out to improve the reproductive performance of pond-sourced *Penaeus monodon* broodstock through supplementation of asthaxanthin (2.3-100 ppm) in the diet. After 60 days, shrimps (body weight, 109 - 144 g) given diets with 50 ppm asthaxanthin attained the highest fecundity of 2,276 eggs/g female. But the highest number of spawnings was observed in shrimps given natural food (squid and mussel meat).

Studies geared to improve artificial diets for shrimp grow-out systems were also conducted. One such study aimed to complete the information on amino acid requirements of *P. monodon*. Based on a 7-week feeding experiment, shrimps fed diet with phenylalanine (incorporation rate of 1.22%) had the highest weight gain. Similarly, an 8-week feeding experiment to test the requirements for histidine shows that 0.87% of histidine gave the highest weight gain. To know the phosphorus requirements of shrimp juveniles, a 90-day feeding test using diets with various graded levels of phosphorus (0, 0.5, 1.0, 1.5, and 2.0%) was conducted. Highest mass weight was attained with shrimps fed diets supplemented with 0.5% P.

An evaluation of protein sources Hamlet Protein (HP 300 and HP 960) to partially replace fish meal showed that juveniles fed the diet containing 12% HP300 had the best growth after 6 weeks.

For shrimp health management, a study to compare the qualitative and quantitative bacterial flora of hatchery-reared and wild-caught *P. monodon* post larvae was conducted. Result shows that hatchery-reared shrimp postlarvae harbor numerous potentially-pathogenic vibrios in their gut, including luminescent strains of up to 2.3×10^3 colony forming units/postlarva. A

relatively low count of up to 5×10^1 colony-forming units/postlarva of luminescent colonies was obtained in wild-caught postlarvae. More samples from the wild need to be processed for comparison. Sensitivity tests showed significant resistance to chloramphenicol and oxytetracycline among isolates from hatchery-reared postlarva (33 and 44%, respectively) compared to bacteria from wild-caught postlarva (3 and 6%) and from nearshore seawater (0 and 12%).

A study to produce antiserum for rapid diagnosis of *vibriosis* in shrimp was conducted. Two luminous bacterial isolates from nearshore seawater and two isolated from adult shrimp were chosen for the study. These were prepared as formalinized antigens and injected into rabbits for antisera production. An antiserum against a luminous bacterial strain from nearshore seawater exhibited a titer of 1.024 after the 5th booster injection.

The aim of the studies on shrimp virus was to determine the prevalence and severity in various life stages of shrimps to guide farmers and fish health workers in designing prevention protocols against viral infections. Samples of postlarvae obtained from various hatcheries show *monodon baculovirus* (MBV) and hepatopancreatic parvo-like virus (HPV) as the dominant viruses detected by light microscopy with prevalence rates of 32 and 30%, respectively. Among pond-reared and wild-caught broodstock the following viruses were detected: MBV, HPV, infectious hypodermal and hematopoietic necrosis virus (IHHNV), and lymphoid organ vacuolization virus (LOW). Transmission experiments showed that the disease develops in healthy postlarvae by feeding them with HPV-infected shrimp carcasses. Mortality and effects of viruses were significant in shrimps stocked at 8 postlarvae per liter compared to those stocked at a lower density of 5 postlarva per liter.

Grouper

One major problem in grouper (*Epinephelus coioides*) seed production is the high mortality observed during larval stages and during metamorphosis. Efforts are presently being focused on nutritional, environmental and hormonal manipulations to improve survival and produce healthy juveniles.

One study compared growth and survival

in larvae fed rotifers enriched with either Protein Selco, Culture Selco or *Chlorella* (control). While the type of food did not affect growth rates, larvae fed rotifers enriched with Protein Selco showed higher survival compared with larvae given rotifers fed *Chlorella* (control) or Culture Selco.

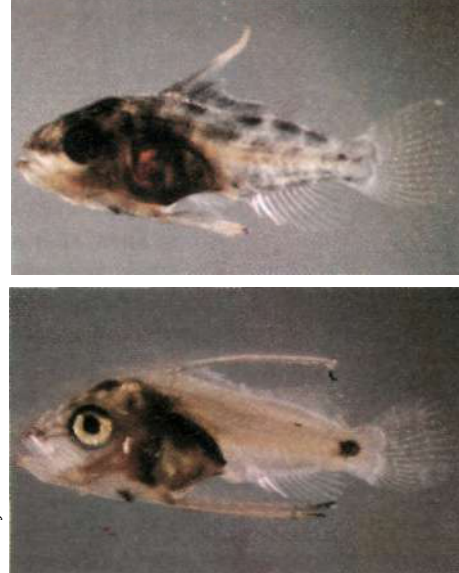
At present, grouper culturists rely heavily on trash fish to feed their stocks. Thus, one major thrust of AQD's grouper R&D is to develop practical diets for nursery and grow-out operations. One study examines the effect of dietary phospholipid supplements on growth of grouper larvae and juveniles. Larvae fed the diet supplemented with marine fish showed the highest weight gain. Highest survival was observed in larvae fed the diet supplemented with newly hatched *Artemia* while larvae fed the diet added with soybean as phospholipid source showed the lowest survival.

Studies have been conducted to define the optimum conditions for culture of grouper larvae and juveniles. Tests on salinity and temperature tolerance of grouper larvae and juveniles indicated that survival of Day 20 larvae was high at 8 and 18 ppt and low at 32 and 40 ppt. Survival was generally higher at 25°C than 30°C at all salinities. On the other hand, survival of Day 40 larvae was higher at 30°C than 25°C regardless of test salinities.

Grouper larvae show highly variable growth rates and metamorphosis is asynchronous, a situation which renders the smaller larvae more vulnerable to cannibalism by their bigger siblings. Thyroid hormone treatment accelerates metamorphosis in grouper larvae. A low dose of 0.01 ppm of thyroid hormone improved survival.

AQD verified the nursery and grow-out culture of grouper at the FGS Farm in Brgy. Sum-ag, Bacolod City.

Grouper fry (2-4 cm, 3.8 g) were reared in 4 x 2 x 1.5 m hapa nets inside the brackishwater pond for 30 days at stocking density of 60 fry / sq m. Survival was 93%; final weight, 14.9 g. Total feed consumed (finely chopped trash fish and mysid shrimps) was 225 kg, a feed conversion ratio of 3.59. Mean relative growth increment was 0.365 g/day/fish.



EG de Jesus

Thyroid hormone treatment accelerates metamorphosis in grouper larvae. Note the difference between treated larvae (top) and untreated larvae.

Production from a 0.9 ha pond was 1,512 kg live grouper after a series of selective harvest. The stocking density was 0.5 fish / sq m, survival rate was 80%, and average live weight at harvest was 450 g. Total feed consumed (trash fish) was 5,783 kg, a feed conversion ratio of 3.82. Mean relative growth increment was about 2 g / day / fish.

Seabass



Dr. G. Javellana analyzes stomach content (right) of seabass juveniles.



To enhance egg survival and production of viable larvae, a study identifying egg quality parameters in the sea bass was conducted. Fertilization was zero to very low at the start (May and June) and at the end (September and October) of the spawning season. In fish that spawned two consecutive days in a month, eggs during the second spawn had significantly higher percentage of normally dividing and developing embryos. Hatching rate, percentage of normal larvae, and total length and oil globule diameter of newly-hatched larvae were generally higher in eggs during the second spawn although the values were not significantly different from those obtained in eggs during the first spawn.

Studies on digestion and gut evacuation rates in sea bass juveniles showed that sea bass fed enriched, non-enriched *Artemia* (Day 4) or wild copepods had average gastric digestion time of approximately 1.0, 4.5, and 4.5 h respectively. Analysis of stomach contents one hour after onset of feeding showed an average ratio of intact vs partially digested food as 4.3 (enriched fed), 64.5 (non-enriched *Artemia*-fed), and 3.1 (copepod-fed). Sea bass juveniles (mean total length of 5.8 cm) can ingest as much as 4 live tilapia or goby fry (total length of about 11 mm) in the first hour of feeding. They had an average gastric digestion time of approximately 4 h.

Immune modifiers or immunostimulants can heighten the nonspecific defense mecha-

nism in fish inducing a generalized protection against pathogens. Exposure of sea bass for one hour to formalin (100 and 300 ppm) and copper sulfate (50 and 100 ppm) did not significantly change plasma lysozyme levels. Aluminum chloride (50 ppm) slightly increased while zinc chloride (50 ppm) slightly decreased plasma lysozyme levels. B-glucans can also significantly increase plasma lysozyme activity in seabass.

Snapper

Broodstock of mangrove red snapper spontaneously matured after 3 years in captivity. The broodstock were either wild-caught, hatchery-reared juveniles in concrete tank (150-ton, 2m deep) or reared in floating net cages (5x5x3m deep). This is the first report indicating that it takes 3 years for mangrove red snapper to commence sexual maturity. However, only males (2-3 kg BW) were found to be spermiating and females have yet to possess vitellogenic oocytes. A mature female (5.7 kg BW) and mature male (4.8 kg BW) spawned 1.07 (June), 3.01 (August), 3.19 (September), and 1.12 (October) million eggs following a single intramuscular injection of 1,000 IU hCG. The high fecundity of the species may delineate the need for a big number of broodstock to supply eggs for hatchery operation.

Hatching rates were higher when eggs were abruptly transferred to higher salinities (32 and 40 ppt) than to lower salinities (8, 16, and 24 ppt). Survival was higher when larvae were reared at low stocking density (1000 ind/ton at day 0 to day 21, and 100 ind/ton at day 22 to day 50) and in bigger-sized tanks (10-ton capacity at day 22-day 50). There is evidence to indicate that thyroid hormone treatments given to 3-week old larvae may improve survival by accelerating metamorphosis and possibly minimizing cannibalism.

Seaweeds

Seaweeds and seaweed products have good markets locally and internationally. Aquaculture production of two varieties of the carrageenan producing red seaweed *Kappaphycus alvarezii*, and agar yield from natural populations of another red seaweed, *Gracilariopsis bailinae*, were studied.

Abalone

AQD is conducting four studies on the tropical abalone *Haliotis asinina*, all focusing on seed production. The first study deals with raising natural food - epiphytic diatoms - for abalone postlarvae. Diatoms slurries with cell densities of 30×10^3 cells per cm^2 can reach the exponential phase of growth - 1.6 to 3.0×10^5 cells per cm^2 - in 14 days when a commercial grade fertilizer mixed with sodium metasilicate is used and the culture is placed under direct sunlight. In contrast, exponential phase is reached in 50 days when culture is placed indoors. The diatoms are mainly 75% *Navicula*, 22% blue-green algae, and 3% *Nitzschia*.

The second study determines the stocking density of abalone larvae in indoor tanks. So far, abalone density of 100 larvae per liter yielded better survival than 200, 400 or 600 larvae per liter. Diatoms such as *Cocconeis*, *Achnanthes*, *Mastogloia* and *Navicula* were first propagated on corrugated PVC plates to a density of 1.35-1.42 million cells per cm^2 before 2-day old abalone larvae were stocked. These diatoms were maintained by twice-weekly fertilization of urea-sodium silicate-ferric chloride combination. The problem in the larval rearing trials is the low settlement rate of abalone larvae. Survival is low, 0.1-1.2% or about 16-177 abalone per tank (150 li capacity).

The third study deals with the effects of photoperiod on food consumption, growth and survival of early juveniles.

The fourth study was designed to come up with a practical feed as an alternative to seaweed. Seaweed is the natural diet of abalone in

the wild, and is commercially important in itself. Abalone juveniles fed the diet containing 32% crude protein and 3.09 kcal per kg ME gained the most weight - 341% - and had the highest specific growth rate - 1.78% per day - compared to those fed the seaweed *Gracilaria heteroclada* (17% protein). The artificial diets were given in various shapes - noodles, oblong or square - and fed to abalone *ad libitum*. Feed conversion ratio of the artificial diet ranged 1.5-2.3 and protein efficiency ratio ranged 9-1. Both were higher than the ratios for seaweed. Survival of the juveniles was generally high - 75-100% - regardless of treatment.

AQD is breeding seahorses in indoor tanks. Seahorses are very much in demand in traditional Chinese medicines or preparations, and resource managers fear extinction of the species if the trend continues.

Marine ornamental fish



Studies focus on seahorse broodstock development and juvenile production of *Hippocampus histrix* and *H. erectus*. About 265 hatchery-reared *H. histrix* broodstock and some 281 second generation offspring have been produced from 17 breeders. Three pairs of wild *H. erectus* have been breeding almost every two weeks and have produced about 58 potential breeders.

Parturition (or giving birth) occurs year-round, but viable broods were obtained only from January to March for both species. Alternative food organisms, a suitable feeding scheme, and improved water management for broodstock and juveniles may enhance brood viability.

AQD has successfully bred the abalone in captivity. To refine hatchery production, studies on feeds and feeding are on-going.



Journal publications

Research papers published in scientific journals and conference proceedings are the output of AQD researchers. These research papers are the raw materials for technology generated by the Department. In 1997, 25 publications were published in science journals and 14 in conference proceedings. Twenty-five papers were accepted by science journals for publication while 19 were presented in scientific meetings.

Collaborators

AQD implemented a total of 27 research projects in 1997. Another 24 studies are collaborations with various organizations and agencies:

- Australian Center for International Agricultural Research (ACIAR)
- European Union (EU)
- International Center for Living Aquatic Resources Management (ICLARM)
- Philippine Bureau of Fisheries and Aquatic Resources (BFAR)
- Philippine Council for Aquatic and Marine Research and Development (PCAMRD)
- International Development Research Centre (IDRC) of Canada
- International Foundation for Science, Sweden (IFS)
- Japan International Cooperation Agency (JICA)
- University of Hohenheim, Germany (UH)
- Tufts University, USA
- Hamlet Protein A/S, Denmark (Private Sector)
- Lonza, Ltd., Switzerland

Breakdown of research publications (January-December 1997):

	Scientific journals	Proceedings	Other publications	Presented in scientific meetings	Accepted for publication / in press
Milkfish	2	1	—	—	1
Grouper	5	2	—	—	5
Red snapper	1	1	—	—	1
Sea Bass	1	—	—	—	1
Tilapia	—	—	—	4	—
Catfish	2	1	—	—	3
Giant tiger shrimp	7	2	—	1	6
Mud crab	—	—	—	4	—
Seaweeds	3	—	1	—	—
CFRM	—	1	—	2	1
Mangroves	1	1	—	1	2
Abalone	—	—	—	1	1
Window-pane shell	—	—	—	—	1
Others	3	5	—	6	3
TOTAL	25	14	1	19	25

Research awards received in 1997

Two AQD papers won the 1997 Dr. Elvira O. Tan Memorial Award. The first paper "Tilapia cage culture and the dissolved oxygen trends in Sampaloc Lake, Philippines", published in *Environmental Monitor. Assess.* 24:243-255



by Alejandro E. Santiago and Renato P. Arcilla won the award for the aquaculture category. The paper assessed the dissolved oxygen condition of Sampaloc Lake in the late 1989, 1990 and

AQD researcher Alejandro Santiago studied the tilapia cage culture and dissolved oxygen trends in Sampaloc Lake and won the Dr. Elvira Tan Memorial Award for 1997 in the aquaculture category. ..

Corazon Santiago, scientist, won a special award during the 11th Dr. Elvira Tan Memorial Awards for her paper that investigated the effects of dietary lipid source on reproductive performance and tissue lipid levels of Nile tilapia broodstock.

Ecological management of Philippine lakes in relation to fisheries and aquaculture

Two-tailed action plans were formulated as regards rational management of Philippine lakes. This was discussed in a seminar-workshop held in Quezon City from 21 to 23 October. Co-sponsored by AQD, the Bureau of Fisheries and Aquatic Resources (BFAR) and the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), the seminar-workshop was attended by 105 participants from all over the Philippines who are working on the conservation and management of Philippine lakes.

The short-term action plan (1998-2000) included the publication of an updated list of Philippine lakes with basic data validated by region; the conduct of rapid resource appraisal, limnological studies to include information of

physico-chemical parameters; and the publication of the proceedings of the seminar-workshop.

The long-term plan included: the conduct of enhancement and evaluation studies with socio-economic components; intensification of ecological modeling; implementation of proper land use and planning; and intensification of stocking and rehabilitation.

Market acceptability of hatchery-produced fry

The conference on the culture of hatchery-produced milkfish fry was the focus of the 1997 D.K. Villaluz Memorial Lecture Series at AQD on 9 July, where the participants identified factors that hinder the acceptability of hatchery-reared fry and recommended directions to enhance its market acceptability.

Among the recommendations were: (1) establishment of more demonstration farms in collaboration with government agencies to show pond operators the viability of the hatchery-produced fry; (2) coming up with a technique in grading and sizing hatchery-reared fry so that these could be sold in uniform sizes, a traditionally accepted practice among fishfarmers; (3) conduct of continuous basic research studies on the causes of deformities including nutritional requirements and physical aspects, in order to improve the quality and acceptability of hatchery-reared fry; (4) conduct of verification studies on larval nutrition in the hatchery as well as in the nursery and transition ponds; (5) conduct of genetic studies as genetics can be a possible factor contributing to the cause of fry abnormalities; (6) assessment of the estimated maximum number of required milkfish broodstock which was established at 250,000 pieces more than two years ago, in view of the recent development in egg production resulting from broodstock nutrition studies.

The conference was attended by 95 pond owners, hatchery operators, aquaculturists, representatives from the academe and government sectors, and AQD researchers.



mid-1991 which showed ominous trends that adversely affect the use of Sampaloc Lake for fishery.

The second paper "Effects of dietary lipid source on reproductive performance and tissue lipids on Nile tilapia, *Oreochromis niloticus* (Linnaeus) broodstock," published in *J. Appl. Ichthyol.* 9:33-40 by Corazon B. Santiago and Ofelia S. Reyes was given a special award. The paper investigated reproductive performance of Nile tilapia fed diets supplemented with the following lipid sources at 5% level: cod live oil, corn oil, soybean oil, a coconut oil-based cooking oil, or a combination of cod liver oil and corn oil (1:1). Fish fed the soybean oil diet had the best overall reproductive performance.

The memorial award is sponsored annually by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) for outstanding research in various fields of fisheries development.

The Technology Verification Project

The TVP continued to intensify its activities - field testing specific culture systems in selected farm sites and packaging technologies that are found to be economically feasible. In 1997, there were ten studies involving brackishwater pond and cage culture as well as broodstock development and seed production of commercially important fishes and crustaceans:

- Completed study on the culture of grouper *Epinephelus* spp. in brackishwater ponds in Sum-ag, Bacolod City. Study to be continued in other sites for commercialization and production purposes in 1998.
- Completed study on the culture of mud-crab *Scylla* spp. in brackishwater ponds in E.B. Magalona, Negros Occidental. Study to be continued in other sites.
- On-going study on nursery and grow-out of milkfish derived from hatchery seeds. To be verified on various sites in 1998.
- On-going study on tilapia culture management in small-water impoundments in

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Training activities

AQD for the first time conducted training outside its host country, the Philippines. The 2-week Sustainable Aquaculture and Coastal Resource Management was held in Cantho University, South Vietnam. Part of the course was a field exercise in resource assessment

AQD continued to train aquaculture manpower for the region. About 94 aquaculturists attended the six international short-term training courses offered in 1997 - Culture of natural food organisms, Aquaculture management, Fish health management, Marine fish hatchery, Freshwater aquaculture, and Fish nutrition. These courses are AQD's yearly regular offerings.

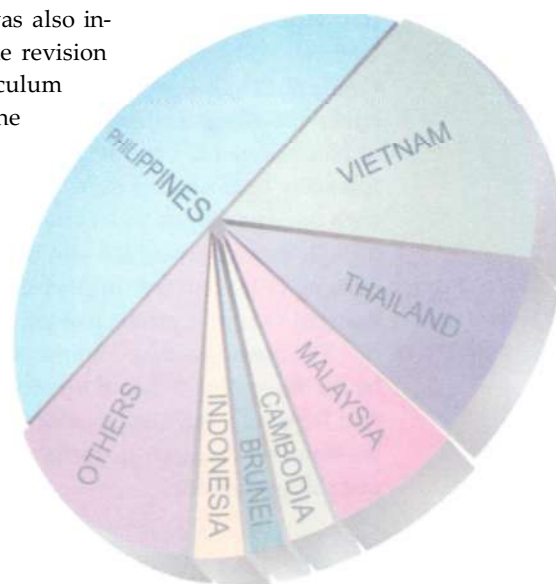
The one-month third-country training on *Coastal Aquaculture and Resource Management* is a 5-year collaboration with Japan International Cooperation Agency. The 1997 session had 14 participants. A shorter (2-week) version of this course was held in Cantho University in Vietnam with 22 attendees representing the academe, research, and government institutions in north, central and south Vietnam. It was the first training course held by AQD outside the AQD

host country, the Philippines. As in other SEAFDEC training courses, it included practical sessions or field exercises for mangrove, coral, seagrass resource assessment and farmer-participatory methods for getting baseline data.

More than 90 aquaculturists attended the courses especially arranged for requesting parties like the Fiji government, University of Western Cape (South Africa), the Philippine Department of Agriculture and Technical Education for Skills Development Authority. The special courses were on shrimp culture, milkfish farming, sustainable aquaculture / coastal resource management, and aquaculture technology.

The attendance in the AQD regular and special courses, by country, shows more trainees coming from the Philippines (116) followed by Vietnam (36), Thailand (15), Malaysia (13), Indonesia (5), Cambodia (4), and Brunei Darussalam (3). Another 28 represented various countries.

AQD was also involved in the revision of the curriculum leading to the Diploma in Fishery Technology (major in Aquaculture) of fishery schools in east central Philippines.



LMB Garcia

Information dissemination

AQD consolidated and improved its information activities, publishing only one newsletter instead of two, placing a website in the Internet, and utilizing the mass print media to some extent to publicize program results.

AQD newsletter. The new bimonthly SEAFDEC *Asian Aquaculture* was published beginning June 1997, and will have six issues a year. It is the result of merging the 4-issue SEAFDEC *Asian Aquaculture* and the 6-issue *Aqua Farm News*. It carries a new masthead but continues the volume number of the old SEAFDEC *Asian Aquaculture*. The merger of the two newsletters was partly cost-cutting as the mailing lists were similar, eliminating publication delays, and improving print quality. The new bimonthly features one special topic each issue covering aquaculture species, farming systems, among others. For 1997, the topics included abalone culture, mudcrab culture, seabass culture, and integrated farming. The bimonthly also has AQD news, original paper contributions, and interviews.

Milkfish poster, conference proceedings. AQD has drawn the natural life history of milkfish in a 83 x 61 cm color poster based on AQD's almost 24 years of research into milkfish ecology and biology.

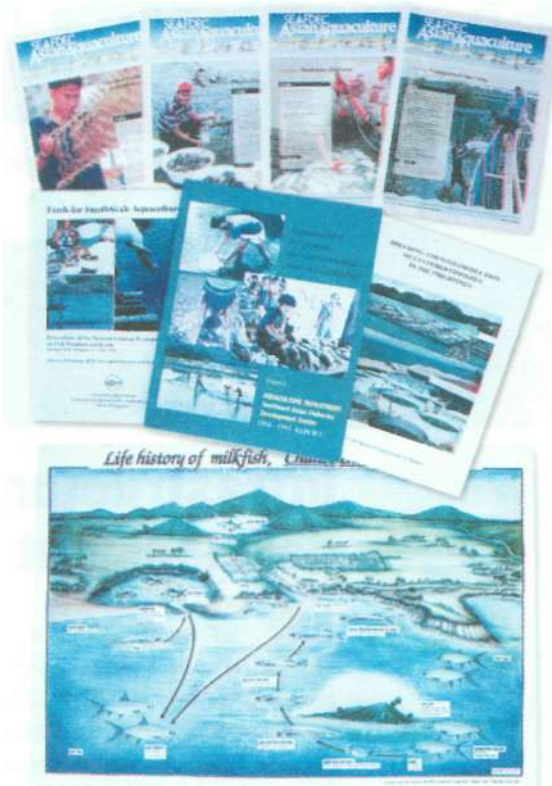
AQD also published two proceedings volume in 1997: the 144-page *Feeds for small-scale aquaculture* edited by CB Santiago et al and the 182-page *Breeding-seed production for cultured species* edited by CL Marte et al.

<http://www2.mozcom.com/~seafdec>. This is the Internet address of the AQD's website which was officially launched July 9.

The site describes AQD's current activities such as on-going research studies, training courses scheduled for the year, and collaborative programs/technology verification field studies in cooperation with fishfarmers. The website also lists AQD's research publications in scientific journals covering 1995-1996 (reprints may be requested from AQD authors) and farmer-friendly extension manuals and videos (ordering information is included). More than 100 surfers have visited the site.

AQD in the mass media. Over 70 news articles in national dailies or newspapers in the Philippines reported AQD's research and training activities. There was much interest among the newspapers on the community fishery resource management project, the *Oplan-Sagip Sugpo* task force which AQD spearheads, hatchery-reared milkfish fry, the lake conference in October, and AQD's various training courses.

The AQD library continued to share information and answer queries from SEAFDEC Member-Countries, among others. It prepared the final draft of the *Abstract on aquaculture nutrition and feeding of freshwater fishes in Southeast Asia (1953-1995)*, a FAO project. The library increased its holdings by more than 500 volumes.



Bingawan, Iloilo.

- On-going study on mudcrab culture in mangrove or tidal zone using nylon net enclosure in Barangay Manalo, Puerto Princesa, Palawan.
- On-going study on broodstock management of economically important cultured fishes in Señorita Island, Honda Bay and at DA-Inland Searanching Station, Tiniguiban Cove (Puerto Princesa, Palawan).
- On-going study on the use of environment-friendly scheme to minimize occurrence of

diseases in prawn farms in two sites in Negros Occidental.

- On-going study on aqua-mangrove integrated farming and mudcrab culture in tidal flats with existing mangroves in New Buswang, Kalibo, Aklan.
- On-going study on commercialization of the raft technology for oysters and mussels in Aklan and Capiz.
- On-going study on the culture of *Gracilariopsis* and milkfish in brackishwater ponds at ISCDF, Barotac Nuevo, Iloilo.



Infrastructure development

The construction of the Integrated Fish Broodstock and Hatchery Demonstration Complex was initiated in 1997. This facility will showcase AQD's fish breeding and hatchery technologies, and demonstrate to fish farmers and entrepreneurs the commercial viability of such technologies.

The facility will also be used to verify further improvements in hatchery techniques developed through continuing research efforts. It will also be used as a training facility for fish hatchery training courses.

The complex includes: broodstock, larval, and natural food production tanks, filter reservoir, and support systems.

Administration

AQD's top management includes: Rolando R. Platon, PhD, *AQD Chief*; Yasuho Tadokoro, *AQD Deputy Chief*; Clarissa L. Marte, PhD, *Research Division Head*; Renato F. Agbayani, *Training and Information Division Head*; Dan D. Baliao, *Administration Division Head*; Rene V. Alger, *Finance Division Head*.

As of 31 December 1997, AQD's permanent staff totalled 350, with 151 in Research, 33 in Training and Information, 121 in Administration, 22 in Finance, and 23 in the Office of the Chief. This includes the 49 employees who were separated from service effective 1 January 1998, under Executive Order No. 8. The Order implemented the recommendation of the SGV consulting firm on streamlining functions, reducing the number of existing personnel, and prescribing a special separation/retrenchment package of benefits.




Platon



Tadokoro

Below: fixed, off-bottom line method of farming *Kappaphycus*. Left: green and red varieties of *Kappaphycus alvarezii*.

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The culture of *K. alvarezii* for a period of one year using two varieties (brown and green), three culture techniques (hanging long line, fixed-bottom line, and hanging long-fixed bottom), and two culture days (60 and 90 days) showed that both brown and green varieties are appropriate for commercial cultivation. Sea-

sonality of growth, biomass production and carageenan properties of each strain, and high profits from this aquaculture endeavor were also observed.

Agar yield from *G. bailinae* showed seasonal variation with higher values obtained in December, March and April.

Catfish

An artificial seminal plasma (ASP) was developed for *Clarias macrocephalus* based on the composition of major cations in the seminal fluid and factors that initiate sperm motility. The optimum milt dilution was also determined to minimize the number of males to be sacrificed during artificial insemination.

The seminal plasma of *C. macrocephalus* had a 



AQ Hurtado-Ponce

Finance

The contribution, grants and other income received by AQD from January 1 - December 31, 1997 are as follows:

Contributions

Philippine Government	\$ 4,994,622.00
Government of Japan	511,579.00

5,506,201.00

Grants

JICA	40,334.00
Department of Agriculture	34,378.00
University of Hohenheim	27,244.00
Lonza AG	22,609.00
FAO	17,744.19
ACIAR	4,075.00
PCAMRD	3,752.35
Dr. Ali Abed, K.S.A.	3,000.00
Hamlet Protein	2,445.00
D.A.K.A. A.M.B.A.	2,492.00
Cantho University	1,729.00
Tufts University	1,493.00
ICLARM	1,200.00
Simon Fraser University	870.00

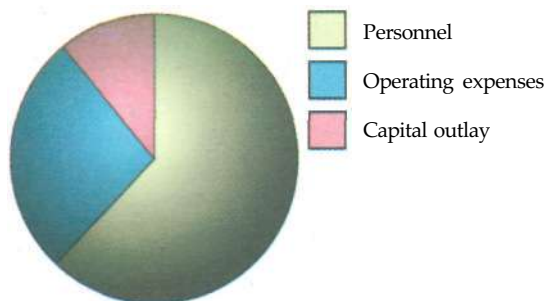
163,365.54

Other income 268,224.00

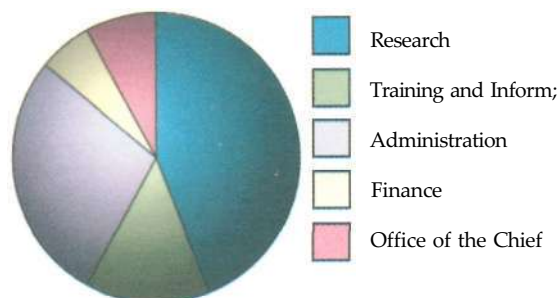
Total \$ 5,937,790.54

Summary of expenses

(unaudited, as of December 31, 1997)



By classification	Amount
Personnel	P 122,396,897
Operating	52,926,954
	175,323,851
Capital outlay	P 21,488,641
Total	P 196,812,492



By function	Amount
Research	P 77,292,031
Training and Information	25,045,579
Administration	48,428,329
Finance	11,068,389
Office of the Chief	13,489,523
Total	P 175,323,851



high ratio of sodium (Na) to potassium (K), osmolality and pH of 269 and 7.8, respectively. Sperm motility was mainly due to a decrease in osmotic pressure (50-200 mOsm/kg), rather than ions and pH. Catfish sperm became motile upon activation when diluted with the ASP at ratios of 1:100-1:200, but were irreversibly inactivated at 1:300-1:1000. High fertilization rates (89-94%) were observed when milt diluted 1:100 with the catfish ASP was activated with 0.6% NaCl to fertilize 5 or 10 g of ovulated eggs.

Catfish fingerling production in the nursery was tested both in concrete tanks and net cages installed

in ponds at varying stocking densities.

At stocking densities of 200 and 300 fry/m², growth of catfish fry after 28 days of rearing was faster in ponds (6.1-6.3 cm, 2.1-2.4 g and 5.1-5.7 cm, 1.2-1.9 g, respectively) than in tanks (3.8-4.1 cm, 0.51-0.68 g and 3.9-4.2 cm, 0.56-0.58 g, respectively).

Survival rates, however, were higher in tanks (73% and 82%, respectively) than in ponds (50% and 26%, respectively). Size and survival rate were more uniform when catfish fry were grown in tanks than in net cages installed in ponds.

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in the region. Its Member Countries are Japan, Malaysia, the Philippines, Singapore, Thailand, and recently, Brunei Darussalam and the Socialist Republic of Viet Nam.

Representing the Member Countries is the Council of Directors, the policy-making body of SEAFDEC. The chief administrator of SEAFDEC is the Secretary-General whose office, the Secretariat, is based in Bangkok, Thailand.

Created to develop fishery potentials in the region in response to the global food crises, SEAFDEC undertakes research on appropriate fishery technologies, trains fisheries and aquaculture technicians, and disseminates fisheries and aquaculture information. Four departments were established to pursue the objectives of SEAFDEC.

- The **Training Department** (ID) in Samut Prakan, Thailand, established in 1967 for marine capture fisheries training
- The **Marine Fisheries Research Department** (MFRD) at Changi Fisheries Complex, Singapore, established in 1967 for fishery post-harvest technology
- The **Aquaculture Department** (AQD) in Tigbauan, Iloilo, Philippines, established in July 1973 for aquaculture research and development
- The **Marine Fishery Resources Development and Management Department** (MFRDMD) in Kuala Terengganu, Malaysia, established in 1992 for the development and management of the marine fishery resources in the exclusive economic zones (EEZs) of SEAFDEC Member-Countries.

The SEAFDEC Aquaculture Department is mandated to:

- promote and undertake aquaculture research that is relevant and appropriate for the region
- develop human resources for the region
- disseminate and exchange information on aquaculture

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